Community Dental Health (2017) **34,** 157–162
Received 27 October 2016; Accepted 27 February 2017

doi:10.1922/CDH_4085Jones06

The caries experience of 5 year-old children in Scotland in 2013-2014, and in England and Wales in 2014-2015. Reports of cross-sectional dental surveys using BASCD criteria

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Objective: We report the findings from and comment on the surveys of the oral health of 5-year-old children undertaken in Scotland (2013-14), Wales (2014-15) and England (2014-15). This was the fourteenth survey in Scotland since 1988. In England and Wales it is the third survey since 2007 when changes were required in consent arrangements. ***Method:*** Representative samples were drawn within Health Boards across Scotland and local authorities across England and Wales. Consent was sought via opt-out parental consent in Scotland and opt-in parental consent in England and Wales. Children examined were those aged five in England and those in Primary 1 (school year aged 5 to 6) in Scotland and Wales. Examinations were conducted in schools by trained and calibrated examiners. Caries was visually diagnosed at the dentinal threshold. ***Results:*** There is a continuing decline in $d_3$mft in all three countries. $d_3$mft was 1.27 (opt-out consent) for Scotland, 0.84 for England (opt-in consent) and 1.29 for Wales (opt-in consent). Tooth decay levels remain higher in more deprived areas across Great Britain, with clear inequalities gradients demonstrated across all geographies. Attempts to measure changes in dental health inequalities across the three countries show no conclusive trends. ***Conclusion:*** Inter-country comparisons provide further oral health intelligence despite differences in approach and timing. The third surveys in England and Wales using the new consent arrangements have enabled trend analysis. Dental health inequalities gradients were shown across all geographies and all of the indicators of inequality.

Key words: *epidemiology, dental caries, caries prevalence, national surveys, children*

Introduction

This paper reports on the data from surveys of the oral health of children at the start of formal primary (elementary) education carried out in Scotland, Wales and England during the school years 2013-2014 or 2014-2015. Fieldwork was carried out by National Health Service clinical teams using training, calibration, sampling and caries measurement criteria established by the British Association for the Study of Community Dentistry (BASCD) (Pine *et al*, 1997a, 1997b, Pitts *et al*, 1997). United Kingdom (UK) level national training was provided by BASCD for Regional Coordinators, trainers and standard examiners using criteria consistent with previous surveys and the BASCD criteria.

In all countries examinations were carried out in state-funded, mainstream primary schools using standardised portable equipment, techniques and conventions. Dental caries was diagnosed at the caries into dentine (d_3) level using the visual method only. Neither radiography, nor transillumination, nor compressed air were used.

The introduction of a requirement for positive parental (opt-in) consent in England and Wales in 2006 prevents direct comparison of results with Scotland (Davies et al, 2011), where legislation allows passive parental (opt-out or negative) consent, which underpins their National Dental Inspection Programme. Despite changes in methods of weighting results, Scotland can now undertake retrospective comparison with data collected back to 1988. England and Wales established new baselines because of the change in consent methods and have collected data using the revised approach three times since then (2007-08, 2011-12 and 2014-15). The 2014-2015 data allow the monitoring of decay trends over the last seven years in England and Wales. This paper provides an overview of the results, signposts to the complete results and analyses the data from these three UK countries using published measures of dental health inequalities.

Scotland

Method

Training and calibration of 51 fieldwork teams was carried out in October/November 2013 in line with BASCD criteria (Pine et al 1997b). Calibration sessions involved each inspection team examining 10 children. Inter-examiner agreement was assessed using percentage agreement and Kappa statistics assessed at the patient level (Cohen 1960).

Each of the 14 NHS Boards in Scotland identified the number of children needed to obtain a representative sample from their primary one (P1) state school population. The sample sizes provided adequate numbers to allow meaningful comparisons between NHS Boards to be drawn (see national report). The results are weighted for each NHS Board by the 2009 Scottish Index of Multiple Deprivation (SIMD) quintile (Scottish Government, 2009).

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Residential postcode was used to allocate each child to a datazone allowing stratification of the national sample by SIMD. In the course of the survey (called Detailed Dental Inspections in Scotland) 10% of the children in the sample were re-inspected in order to assess the consistency of the decisions of the examining dentists and check for diagnostic reliability during the fieldwork.

A number of measures of dental health inequality are reported; 1) the Significant Caries Index (SiC); 2) The Slope Index of Inequality (SII) and 3) the Relative Index of Inequality (see national report). The Significant Caries Index (SiC) is calculated from the mean $d_3$mft of the one third of the population with the highest caries scores (Bratthall 2000). The Slope Index of Inequality (SII) is a test of absolute inequality, as it reflects the entire socio-economic status (SES) distribution and weights for the population in the respective groups. SII will change in value even if inequality is unchanged but health improves in all deprivation groups. If SII is divided by the mean $d_3$mft the Relative Index of Inequality (RII) can be calculated (Pamuk 1985). This allows comparison over time when oral health is improving.

Results

All 51 dental teams calibrated with percentage agreement ranging from 93% to 100% and the Kappa estimates for $d_3$mft scores at the patient level did not drop below moderate agreement (K=0.41-0.60).

Between November 2013 and June 2014, a total of 16,251 children (estimated at more than 28% of the Primary 1 population) from local authority schools across Scotland were included in the Detailed Inspection. Across the 14 NHS Boards, the proportion of Primary 1 children receiving detailed inspections ranged from 12% to 88%. The average age of the children examined in 2013/14 was 5.5 years for both girls and boys – this was the same as the 2012 survey.

The mean $d_3$mft weighted using the Scottish Index of Multiple Deprivation - SIMD (Scottish Government, 2009) has decreased from 1.35 (2012) to 1.27. The proportion of P1 children having obvious decay experience ($d_3$mft<0) reduced from 33% (2012) to an all-time low of 32%. Across the 14 Health Boards the range of mean $d_3$mft was from 0.64 teeth in Shetland, to 1.45 in Greater Glasgow and Clyde. The range in prevalence of tooth decay experience was from the lowest of 19.1%, again in Shetland, to 34.7% in Greater Glasgow and Clyde.

Figure 1 shows the long term decline in the mean $d_3$mft of Primary 1 Scottish Children. Figure 2 shows the inequalities gradient based on the prevalence of children with tooth decay experience by SIMD decile. While tooth decay is reducing across all deciles, the gradient of the best-fit regression lines approximating to the relative health inequalities gradient does not appear to be changing.

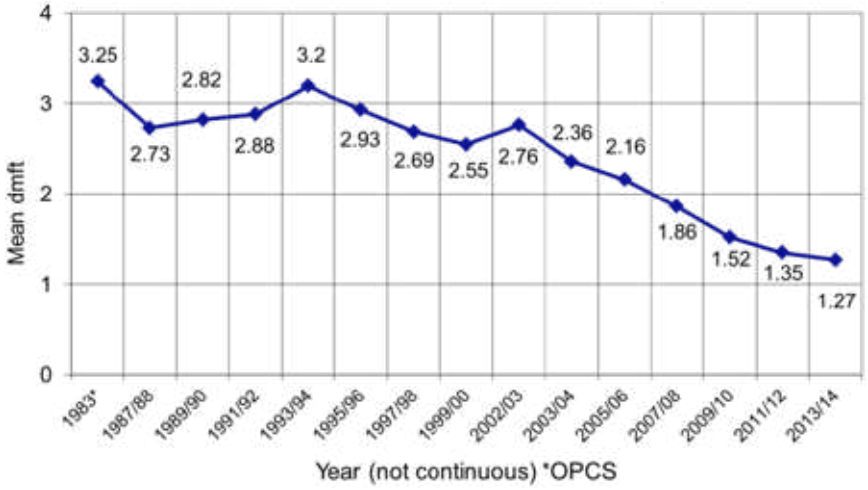

Figure 1. *Mean number of decayed, missing and filled primary teeth ($d_3$mft) in Scottish Primary 1 children, 1983 to 2014*

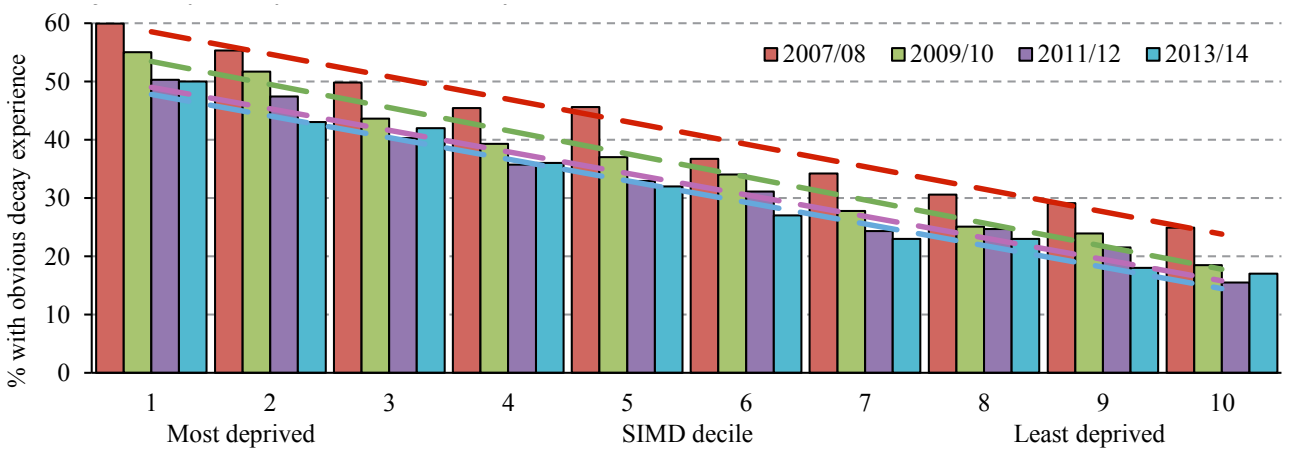

Figure 2. *Proportion of Scottish Primary 1 children with obvious decay experience by Scottish Index of Multiple Deprivation decile; years 2008, 2010, 2012 and 2014*

The SII in 2014 was 1.99, which is an improvement since 2008 (2.24). Similarly, the SiC, also shows an improvement since 2008 (Table 1). The relative index of inequality (RII) for Primary one children was 1.61 in 2014. The variation over time in RII means we cannot confirm that relative dental health inequality among primary one children has reduced, although we can state that absolute inequality measured by SII have not been at the expense of large increases in relative SES inequality in dental health.

Table 1. Dental Health Inequality trends in Scottish Primary 1 children, 2008 – 2014

Year	*d_3mft*	*SiC*	*SII*	*RII*
2008	1.86	5.43	2.24	1.17
2010	1.52	4.5	2.42	1.58
2012	1.35	4.13	2.25	1.63
2014	1.27	3.72	1.99	1.61

Comment

Surveys of tooth decay at the level of Health Boards in Scotland have been in place since 1988. The inclusion of the 1983 UK Child Dental Health Survey (Todd & Dodd 1985) results allow a national trend in mean $d_3$mft to be charted for the last 30 years. Both the mean $d_3$mft and the proportion of children with tooth decay experience show steady improvement since 2003 (see Figure 1), largely credited to the national Childsmile programme which provides a range of preventive interventions. The 2014 mean $d_3$mft value of 1.27 teeth is the lowest since national data began to be collected in 1983. We can confirm that absolute improvements in dental health inequality (SII) have not consistently increased relative dental health inequalities in Scotland (RII). The full report and results of the 2014 survey are available at; http://www.isdscotland.org/Health-Topics/Dental-Care/Publications/2014-10-28/2014-10-28-NDIP-Report.pdf

England

Method

A national protocol was developed based on previous surveys of caries among 5-year-old school children which encompassed BASCD standards for calibration, sampling, examining, recording caries, analysis and reporting (PHE, 2014). A cascaded training and calibration model was employed whereby regional standard examiners calibrated against the UK BASCD standard examiner and then trained and calibrated fieldwork teams in their regions. All regional examiners successfully calibrated against the UK standard at an event organised in July 2014 (see national report).

Explicit consent was sought for all sampled children, as had been the case in the previous two surveys in 2008 and 2012. Information letters and consent forms were sent to parents of sampled children for return to school and this was repeated once where there was no response.

Compliance with the Health and Social Care Act, 2012 is required by all staff undertaking NHS and public health functions on behalf of the Secretary of State (Stationery Office, 2012). The act requires ethnicity to be collected for volunteers in the survey as this would allow reporting of any inequalities measured in dental health. This information was gained from the details schools collect about all children when they enrol.

The other new aspect to the survey was the introduction of a new data collection tool as an alternative to Dental SurveyPlus2 which does not function on new computers.

Results

All 152 upper-tier local authorities (LAs) took part in the survey resulting in estimates being available for 324 out of 326 lower-tier LAs. Consent return levels varied between and within regions. From the randomly drawn samples an average of 63.1% of children were examined. Non-response to the request was the most common reason for non-consent (28.9%), despite two requests and schools actively seeking returned forms. A small proportion of parents (4.5%) returned forms stating they did not want their children included in the survey, while 0.5% of children with consent declined to take part on the day. Absences on the day of examination accounted for a loss of 3.8% of consented children.

Of the children with parental consent 111,500 had valid home postcodes and so were included in the final analysis, representing 95.7% of the main consented sample. This represented 16.5% of the population of this age cohort attending mainstream state schools.

Backward comparison with the 2008 and 2012 surveys which used the same methods of consent is now possible and reveals a trend of reduced severity and prevalence of caries in England overall (Fig 3). The proportion of children in England with obvious decay experience has decreased from 30.9% in 2008 to 27.9% in 2012 and 24.8% in 2015. This represents a decrease of six percentage points since 2008. The mean $d_3$mft score has fallen between 2008 - 1.1 and 2015 - 0.8, this is a 27.3% reduction in $d_3$mft. Analysis using Index of Multiple Deprivation of lower-tier LAs shows that there has been a reduction in decay levels in all socio-economic groups and that the inequalities between them remain (Fig 4).

Computation of caries affecting deciduous incisors allows observations to be made about communities where long term bottle use with sugared drinks is culturally acceptable. This measure has now been added to the tables provided for all upper and lower tier LAs, Public Health England centres and Clinical Commissioning Groups. Overall, the prevalence of incisor caries was 5.6% and this figure varied by region, ranging from 3.6% in the South East to 8.5% in the North West. Comparison at lower-tier local authority level shows far wider variation with a prevalence of 0.3% for Maldon and 20.8% in Oldham.

The requirement for providing coded ethnic background information for each child resulted in 97% of examined children being classified into one of seven ethnic groups using a nationally recognised classification. Analysis shows that the highest levels of decay are found among children of Chinese descent with a particularly high proportion having incisor caries (28%) (Table 2). The next highest level of general decay was found in children from Eastern Europe.

The full reports and detailed tables for England can be found from: http://www.nwph.net/dentalhealth/survey-results%205(14_15).aspx

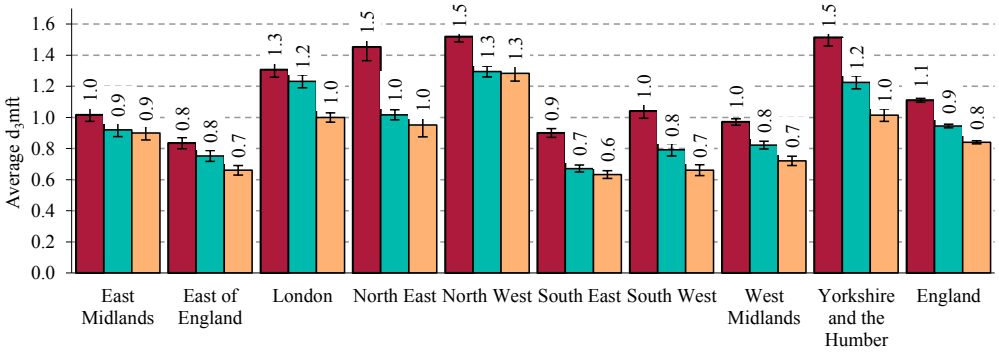

Figure 3. *Average d_3mft among five-year-old children in England by region, 2008, 2012 and 2015*

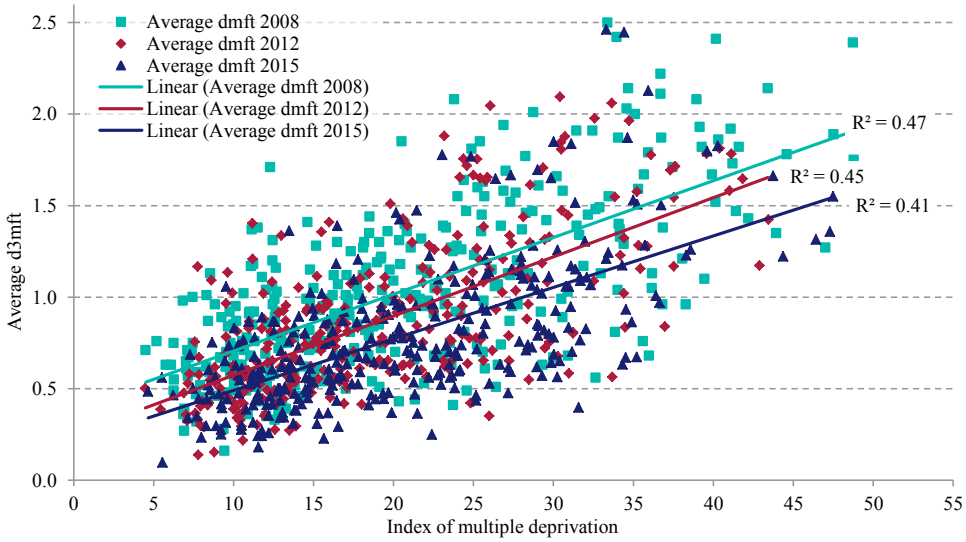

Figure 4. Correlation between mean d_3mft among five-year-old children and Index of Multiple Deprivation score for lower-tier local authorities in England, 2008 (IMD 2007), 2012 (IMD 2010) and 2015 (IMD 2015).

Table 2. Measures of dental caries found in five-year-old children from different ethnic backgrounds in England, 2015

Ethnic group	*Sample size (n)*	*Proportion of children with no obvious caries experience*	*Mean d_3mft*	*Mean d_3mft of those with caries experience*	*Proportion with incisor decay of whole sample*
White	82,162	78.1 (77.77, 78.34)	0.7 (0.68, 0.70)	3.1 (3.11, 3.19)	3.9 (3.75, 4.01)
Mixed	5,164	75.2 (74.04, 76.39)	0.8 (0.75, 0.86)	3.3 (3.14, 3.42)	5.8 (5.17, 6.45)
Asian/Asian British	12,011	63.3 (62.45, 64.17)	1.5 (1.41, 1.50)	4.0 (3.91, 4.09)	12.5 (11.95, 13.13)
Black/black British	5,380	78.6 (77.51, 79.70)	0.7 (0.65, 0.74)	3.3 (3.14, 3.43)	6.1 (5.42, 6.70)
Chinese	544	48.7 (44.51, 52.91)	2.5 (2.24, 2.86)	5.0 (4.56, 5.43)	24.8 (21.19, 28.45)
Eastern European	895	52.4 (49.13, 55.67)	2.2 (1.99, 2.42)	4.7 (4.35, 4.98)	15.1 (12.74, 17.43)
Other ethnicity	2,015	55.4 (53.21, 57.56)	1.9 (1.74, 1.99)	4.2 (4.01, 4.41)	16.7 (15.05, 18.30)
Not provided	3,329	72.1 (70.54, 73.59)	1.0 (0.89, 1.03)	3.4 (3.27, 3.63)	6.5 (5.71, 7.39)
Total	111,500	75.2 (74.95, 75.45)	0.8 (0.83, 0.85)	3.4 (3.37, 3.43)	5.6 (5.46, 5.73)

95% lower and upper confidence limits are shown in brackets

Comment

Now that a series of surveys has been completed using comparable methods it is possible to observe a clear, statistically significant trend of increasing numbers of children who are free of obvious decay and a reduction in the mean number of teeth affected. The specific reasons for this are being analysed and will include the impact of the removal of many low-fluoride children's toothpastes from the UK market. Whilst it is good that caries levels in five-year-olds are improving, overall the findings reveal that about a quarter of all children are still affected by this disease and that pockets of high levels of caries persist.

Detailed use of the data allows LAs, who are the bodies in England who now hold responsibility for improving oral health, to establish where their higher risk populations are sited. They can use the data on general and incisors caries for three and five-year-olds to pinpoint when the children are most at risk and target efforts to support families to establish healthy home care habits (Davies et al, 2016).

Wales

Method

All Welsh Examiners are calibrated in line with the BASCD diagnostic criteria and codes (Pitts et al., 1997). The Wales benchmark examiner attended the UK training exercise held in England and calibrated. The other 13 Welsh examiners calibrated at the Welsh training and calibration exercise. Calibration in Wales was preceded by training on the examination criteria, including two clinical examination sessions, with benchmark examiner feedback (details in the national report).

The samples of state school pupils in each Local Health Board in Wales were drawn in line with BASCD guidance (Pine et al., 1997a). Sample size was calculated from estimated school population (September 2014), to enable production of population caries estimates at Local Health Board level. Proportionate samples were calculated for smaller and larger schools. These were randomly selected to meet or exceed the required sample size. True school population information was collected in January 2015. The raw survey data were combined with true school population data to calculate weighted survey results for the Local Health Boards. Quintile of deprivation data was calculated using the Welsh Index of Multiple Deprivation (Welsh Government 2011).

Results

The 2014/15 dental survey of five year olds in Wales shows a reduction of 6 percentage points in the proportion of children with experience of obvious dental decay (%$d_3$mft >0) when compared with the survey in 2011/12 (41.4% falling to 35.4%). In the eight years since 2007/8 this demonstrates a 12% reduction in the proportion of children with at least one tooth affected by decay (from 47.6%). The fall in the proportion of children with decay experience is mirrored by a similar statistically significant reduction in all Wales mean decay experience ($d_3$mft) from 1.98 in 2007/08 to 1.59 in 2011/12 and now to 1.29 in 2014/15. The improvements in oral health reflect a trend of steady improvement in most Local Health Boards.

While there is little evidence of narrowing inequality across Wales, there is no evidence of widening inequalities associated with these significant improvements in caries levels over the last 8 years (see figure 5). This demonstrates, for the most deprived quintile the proportion of children with decay was 57.6% in 2007/08, 51.5% in 2011/12 and is now 45.4%.

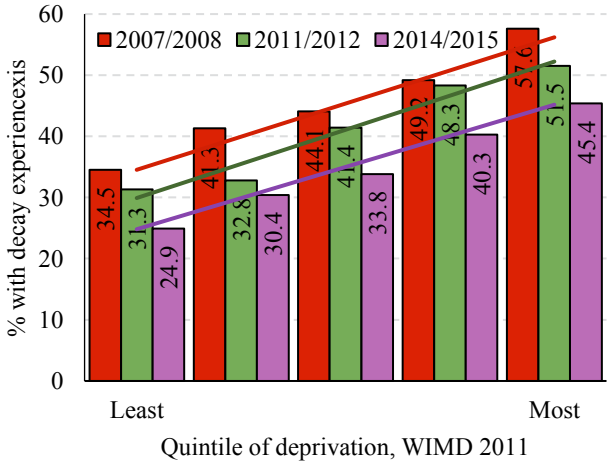

Figure 5. *Proportion of children in Wales with decay experience (%$d_3$mft>0) 2008 – 2015, by 2011 Welsh Index of Multiple Deprivation*

Comment

The Welsh Government would like to see improved oral health particularly for the more deprived population. Dental disease levels in children in Wales continue to improve across all social deprivation groups. The mean d3mft for 5 year olds living in our most deprived areas in 2007/08, 2011/12 and 2014/15 were 2.2, 2.2 and 1.9 teeth respectively.

The Designed to Smile programme was in the early stages of implementation for under 5s in some areas of Wales during 2012 (Chestnutt, 2013). As a result, some of the children surveyed in 2014/15 attending schools eligible to participate in Designed to Smile may not have yet received the full benefits of this programme.

Analyses in this and previous surveys confirm that schools that have been targeted for the Designed to Smile programme currently have greater baseline levels of dental disease. This is to be expected as they were targeted because of historically high disease levels associated with material deprivation. When five year olds survey results for 2015/16 are available the full impact of Designed to Smile should start to emerge.

Great Britain Discussion

Although it is regrettable that we still see significant proportions of the population of 5-year-old / primary 1 children experiencing clinically significant signs (progression into dentine) of a preventable disease, the reductions in disease prevalence and severity seen over time are to be welcomed. The introduction of preventive schemes in Scotland and more recently in Wales does appear to be associated with greater reductions in caries prevalence within a few years of commencement. The results reported from three of the four UK nations suggest that relative inequalities in tooth decay among 5-year-olds have neither increased nor decreased significantly in recent years.

In the context of building an overall picture for the UK, the decennial Child Dental Health Survey for 2013 has now also provided data on the caries experience in 5-year old children, but in this case for England, Wales and Northern Ireland (Vernazza et al., 2016). In addition to overall results for *obvious* decay experience (40%) and mean $d_3$mft (1.2), this survey has also provided estimates of caries where enamel lesions were included - *clinical* decay experience (56%) and mean $d_1$mft (2.0), which are closer to the values seen in clinical examinations of children. They too reported a sizeable minority with a significant burden of disease associated with deprivation (Vernazza et al., 2016).

Acknowledgements

The authors are grateful to those whose efforts ensure that the surveys are carried out including: the Health Departments of England, Wales and Scotland who funded national training and calibration exercises, Regional Coordinators, standard examiners, trainers, the fieldwork teams, schools, pupils and parents. They are also grateful for quality assurance provided by Helen Paisley, for statistical advice and support provided by Alex McMahon and Girvan Burnside on behalf of BASCD and Stefania Greci for secretarial support.

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